By ALLAN H. YOUNG AND CLAIBORNE M. BALL

Industrial Impacts of Residential Construction and Mobile Home Production

This article analyzes the materials and services required for producing single-family houses, multi-unit structures, and mobile homes. The production requirements are based on OBE's recently completed input-output tables for 1963. To the extent that the Nation continues to meet its housing needs with conventional construction and mobile home production, these requirements suggest the industrial impacts that can be expected in the 1970's.

INPUT-OUTPUT analysis is a tool for analyzing the industrial structure of the economy by tracing the relationship between the output of each industry and the inputs required by that industry from other industries. This article illustrates input-output analysis by comparing the industrial requirements for producing several different types of dwelling units: a single-family house, an apartment in each of three types of multi-unit structures, and a mobile home. The comparisons, which are based on OBE's input-output study for 1963, pinpoint the industries whose sales are strongly affected by residential construction and mobile home production. Sales of some industries are found to be strongly affected by each type of housing, while sales of other industries are affected by only one or two types. A unique feature of input-output analysis is that it takes into account not only the effect that an industry has on its direct suppliers, but also on those industries that provide inputs to the suppliers.[1]

The industrial requirements described in this article reflect the technology and price structure prevailing in 1963. It is unlikely that technology and relative prices have changed enough since 1963 to destroy the usefulness of these data. With regard to the future, these figures suggest the industrial impacts that can be expected if the Nation's housing needs in the 1970's are met by conventional construction or mobile home production. However, to the extent that future housing needs are met with types of units not included in this article, such as factory-built modules,

1. The 1963 input-output study is described in "Input-Output Structure of the U.S. Economy: 1963" in the November 1969 issue of the SURVEY OF CURRENT BUSINESS. That article presented the 1963 input-output tables aggregated to 85 industries. More detailed tables showing 367 industries are contained in *Input-Output Structure of the U.S. Economy: 1963, Volume 1, Transactions Data for Detailed Industries; Volume 2, Direct Requirements for Detailed Industries;* and *Volume 3, Total Requirements for Detailed Industries* (available for $1.75 each from the Government Printing Office). Additional detail for 32 types of new construction, including the residential types shown in this article, and 17 types of maintenance and repair construction, and for about 70 manufacturing industries is contained in a transactions table for 478 industries that is available on magnetic tape. Inquiries about purchase of the tapes should be directed to OBE.

The tables in this article show only the industries most affected in terms of their dollar sales by the demands created by constructing dwelling units. Listings of the impacts of residential housing on all 367 industries in the input-output table may be obtained on request.

Table 1.—Direct Requirements Per Dwelling Unit in 1963

[Dollars]

Single-family house		Two- to four-unit structure		Walk-up apartment	
A. Materials	6,944	A. Materials	2,809	A. Materials	4,107
1. Millwork	544	1. Sawmills & planing mills	453	1. Ready mixed concrete	260
2. Ready mixed concrete	509	2. Ready mixed concrete	318	2. Metal doors, sash & trim	258
3. Sawmills & planing mills	436	3. Veneer & plywood	263	3. Sawmills & planing mills	192
4. Prefabricated wood structures	317	4. Metal doors, sash & trim	161	4. Sheet metal work	183
5. Veneer & plywood	304	5. Millwork	158	5. Millwork	181
6. Metal doors, sash & trim	268	6. Blast furnaces & basic steel products	150	6. Blast furnaces & basic steel products	174
7. Blast furnaces & basic steel products	221	7. Wood household furniture	135	7. Forest, greenhouse & nursery products	152
8. Concrete products, n.e.c.	209	8. Heating equipment, except electrical	121	8. Architectural metal work	136
9. Forest, greenhouse & nursery products	195	9. Concrete block & brick	99	9. Gypsum products	132
10. Heating equipment, except electrical	178	10. Forest, greenhouse & nursery products	97	10. Heating equipment, except electrical	131
11. All other	2,224	11. All other	1,848	11. All other	2,310
B. Services	3,459	B. Services	2,327	B. Services	1,993
1. Wholesale trade	991	1. Wholesale trade	740	1. Wholesale trade	492
2. Retail trade	676	2. Retail trade	511	2. Retail trade	463
3. Miscellaneous professional services	462	3. Miscellaneous professional services	282	3. Miscellaneous professional services	390
4. Real estate	296	4. Railroads & related services	206	4. Railroads & related services	139
5. Railroads & related services	249	5. Motor freight transportation & warehousing	143	5. Motor freight transportation	130
6. All other	883	6. All other	345	6. All other	280
C. Value added	5,585	C. Value added	3,271	C. Value added	3,599
D. Total (A+B+C)	15,988	D. Total (A+B+C)	8,998	D. Total (A+B+C)	9,698

the data presented here would have to be supplemented with data on the inputs to such new processes.

Input-output analysis

Input-output analysis translates the demand for goods and services by final users into the requirements placed directly and indirectly on each industry. The data required for making this translation are provided by OBE's 1963 input-output study. The results of the study are contained in three basic tables—the transactions table, the direct requirements table, and the total requirements table.

The transactions table shows the flows of goods and services among industries and to the final users on a basis that is conceptually and statistically consistent with the national income and product accounts. The direct requirements table relates each of an industry's inputs to its total output; it shows the amounts that the industry requires from each other industry as direct inputs to produce a dollar of its output. The total requirements table shows the amounts required by an industry both directly and indirectly from other industries to deliver a dollar of its output to a final user. The technical note at the end of this article describes how these basic tables were used in estimating the industrial impacts of residential construction and mobile home production.[2]

Direct requirements

Table 1 shows the direct requirements in 1963 for producing the average sized unit of each of five types of dwelling unit. The five types are: a single-family house, a unit in a two- to four-unit structure, a unit in a walk-up structure (three stories or less), a unit in a high-rise structure (four stories or more), and a mobile home. The table shows the total cost of producing each type of unit and the composition of the total in terms of the value of purchased goods and services and value added (employee compensation, profits, etc.). The table also shows the 10 industries with the largest sales of goods for use in producing the various types of units and the five industries with the largest sales of services. The 15 industries shown for each type of unit account for well over half of the purchased inputs; the remainder is supplied by about 120 additional industries for residential structures and 70 additional industries for mobile homes.

On average, the cost of producing a single-family house in 1963 was about 1⅛ to 1½ times the cost of producing a unit in the three types of multi-unit structures and 3½ times the cost of producing a mobile home. The primary reason for the cost difference is the difference in size. Single-family houses averaged about 1,400 square feet in 1963 compared with 550 square feet for mobile homes; the scanty evidence available concerning apartments suggests an average of about 900 square feet for units in multi-unit structures. (Data are unavailable for estimating the average sized unit in each type of multi-unit structure.) It is important that these differences in unit size, and hence in production cost, be recognized when comparing the amounts of specific material or service inputs shown for the various types of unit.

Among the different types of dwelling units there are marked differences in the composition of the direct material inputs. The largest suppliers of goods to single-family construction are four wood products industries and the ready-mixed concrete industry. These are followed in order of importance by three metal products industries, a concrete products industry, and the green-house and nursery products industry (whose output is used in landscaping). In contrast, there is no wood products industry among the top 10 suppliers of materials for high-rise apartments: with the exception of ready-mixed concrete (which heads the list) and gypsum products, the largest suppliers are metal products industries.

The top 10 suppliers to the mobile home industry include four industries that are not among the top 10 for any of the construction types. These are motor vehicles and parts, aluminum rolling and drawing, electric housewares and fans, and coated fabrics. A rather more suprising finding is that the two largest direct suppliers are wood products industries. This reflects the fact that the structural system of a mobile home is much like that of a frame house: the floor joists, studs, and roof joists are made of wood and the interior wall panels are usually plywood or composition board.

There is greater similarity among the types of units in the industrial composition of the direct inputs of the service industries. Wholesale and retail trade are the largest suppliers of services to each type of construc-

2. The flows of goods and services among industries recorded in the transactions table represent purchases made on current account. As a result, the direct and total requirements computed from the transactions table also represent purchases on current account. Requirements for plant and equipment are excluded from the analysis.

Table 1.—Direct Requirements Per Dwelling Unit in 1963—Continued

[Dollars]

High-rise apartment		Mobile home	
A. Materials	4,585	A. Materials	2,872
1. Ready mixed concrete	550	1. Veneer & plywood	268
2. Metal doors, sash & trim	498	2. Millwork	206
3. Sheet metal work	263	3. Motor vehicles & parts	202
4. Miscellaneous metal work	264	4. Aluminum rolling & drawing	194
5. Blast furnaces & basic steel products	176	5. Heating equipment, except electrical	144
6. Architectural metal work	158	6. Metal doors, sash & trim	141
7. Wiring devices	152	7. Sawmills & planing mills	112
8. Gypsum products	149	8. Blast furnaces & basic steel products	107
9. Elevators & moving stairways	145	9. Electric housewares, fans	91
10. Pipe, valves & pipe fittings	120	10. Coated fabrics not rubberized	78
11. All other	2,360	11. All other	729
B. Services	2,141	B. Services	1,149
1. Miscellaneous professional services	471	1. Retail trade	397
2. Wholesale trade	452	2. Wholesale trade	316
3. Retail trade	440	3. Railroads & related services	58
4. Motor freight transportation & warehousing	197	4. Motor freight transportation	51
5. Railroads & related services	126	5. Business travel entertainment & gifts	49
6. All other	496	6. All other	110
C. Value added	4,615	C. Value added	1,122
D. Total (A+B+C)	11,341	D. Total (A+B+C)	4,543

tion except high-rise apartments, and also to mobile home production. On the high-rise list, these two industries are outranked by miscellaneous professional services, consisting mainly of architectural services. Other leading suppliers of services are railroad transportation, which is among the top five for all types of dwellings, and motor freight transportation which is among the top five for all types except single-family houses (in which case it is replaced by real estate).

In general, the contributions of wholesale and retail trade are larger than the input from any goods producing industry. In the input-output tables these trade services are measured by the trade margins—selling expenses and profits—involved in the distribution of goods. Lumber yards and building material dealers which are very large suppliers to construction are classified as retail establishments.

The inputs of trade, transportation, and real estate shown in table 1 include certain items that are shown in the published input-output tables as being purchased directly by final demand rather than as inputs to the construction or mobile home industry. These items were included among the inputs in table 1 so as to measure, as nearly as possible, the total cost of the dwelling unit to the final purchaser. The inputs of trade and transportation to mobile homes have been increased to include the trade margin on the sale of the unit to its final purchaser and the transportation from factory to site. The real estate input to the construction of single-family units has been increased to include the commission on the sale of the new home. It should be noted that neither the construction nor mobile home inputs include items such as closing costs, finance charges, or land costs that are usually associated with the purchase of a new dwelling.

Total requirements

Table 2 shows the total requirements for producing each type of unit. Total requirements from an industry include both its direct sales to construction and mobile home production, already discussed, and its sales to other industries that are generated indirectly by construction or mobile home production. The table identifies the top 10 producers of goods and the top five service producers. Each industry's direct sales are shown in table 2 in parentheses following the industry title. The difference between an industry's direct sales and its total sales represents the sales generated by indirect effects; the unique contribution of input-output analysis is that it takes account of these indirect links that relate industries to the filling of final demands.

Among the leading goods producing industries shown in table 2 are several whose indirect sales outweigh their direct sales to residential construction or mobile home production. The logging industry has no direct sales at all; however, its sales to wood products industries put it among the top 10 in total sales generated by mobile home production and by construction of single-family houses and of units in two- to four-unit structures. The primary aluminum industry also has no direct sales but is among the leaders in total sales generated by mobile home production, and the aluminum rolling and drawing industry, with negligible direct sales, is among the leaders in total sales generated by high-rise construction.

The total sales of the blast furnace and basic steel products industry are three times as large as direct sales in the case of single-family construction and mobile home production, and five times as large in the case of high-rise construction. Other industries whose indirect sales are as large or larger than their direct sales, for one or more of the dwelling unit types, include sawmills and planing mills, hydraulic cement, stone and clay mining and quarrying, and petroleum refining and related products.

On the other hand, several industries are among the leaders in total sales because of the size of their direct sales. These industries include millwork, ready-mixed concrete, and metal doors, sash and trim.

Among the service industries, indirect sales outweigh direct sales in the real estate industry and, in the case of high-rise apartments and mobile homes, in the transportation industries. The indirect sales of the real estate industry are largely the rental of space to firms that are meeting either direct or indirect demands of construction. It should be noted that this input tends to be a fixed cost which will not vary proportionately with the output of dwelling units.

Table 2.—Total Requirements Per Dwelling Unit in 1963

[Dollars]

Single-family house		Two- to four-unit structure		Walk-up apartment	
A. Materials:		A. Materials:		A. Materials:	
1. Sawmills & planing mills (483)	859	1. Sawmills & planing mills (483)	709	1. Blast furnaces & basic steel products (174)	597
2. Blast furnaces & basic steel products (221)	658	2. Blast furnaces & basic steel products (150)	429	2. Sawmills & planing mills (183)	327
3. Millwork (544)	566	3. Ready-mixed concrete (318)	327	3. Ready-mixed concrete (260)	282
4. Ready-mixed concrete (509)	541	4. Logging camps & logging contractors (0)	313	4. Metal doors, sash & trim (255)	270
5. Veneer & plywood (304)	497	5. Veneer & plywood (303)	301	5. Petroleum refining & related products (52)	210
6. Logging camps & logging contractors (0)	436	6. Metal doors, sash & trim (181)	197	6. Sheet metal work (158)	198
7. Prefabricated wood structures (317)	323	7. Petroleum refining & related products (38)	183	7. Millwork (161)	188
8. Metal doors, sash & trim (293)	277	8. Millwork (165)	176	8. Forest, greenhouse & nursery products (182)	173
9. Cement, hydraulic (36)	249	9. Cement, hydraulic (62)	160	9. Stone & clay mining & quarrying (41)	158
10. Forest, greenhouse & nursery products (185)	237	10. Stone & clay mining & quarrying (34)	143	10. Industrial inorganic & organic chemicals (2)	153
B. Services:		B. Services:		B. Services:	
1. Wholesale trade (681)	1,378	1. Wholesale trade (780)	991	1. Wholesale trade (482)	782
2. Retail trade (670)	793	2. Retail trade (511)	596	2. Retail trade (468)	540
3. Real estate (268)	685	3. Miscellaneous professional services (382)	467	3. Miscellaneous professional services (300)	473
4. Miscellaneous professional services (462)	684	4. Railroads & related services (206)	344	4. Real estate (58)	310
5. Railroads & related services (266)	470	5. Real estate (39)	299	5. Railroads & related services (139)	274

NOTE.—Amounts in parentheses represent the value of direct requirements.

Industrial markets

Table 3 illustrates how input-output analysis provides information on the relationship between final demand and an industry's sales to its various customer industries. For two selected industries—plastics materials and resins, and railroads—the table shows the total sales generated by the production of each type of dwelling unit and the distribution of the total between the direct sales to the construction and mobile home industries and the sales to other industries. This type of information is particularly useful in such applications of input-output analysis as market research by a firm that is only remotely linked to a final demand, such as housing, but nevertheless interested in determining which markets expand or contract in line with shifts in that final demand sector.

To obtain the distribution of an industry's sales among its customers involves two computations which are briefly described here for the plastics materials and resins industry. First, the total requirements placed on each industry as a result of producing one dwelling unit are computed. Second, the direct requirements that each industry places on the plastic materials industry in order to meet its total requirements from construction or mobile homes is computed. These direct requirements are the total sales by the plastics materials industry to each of its customers as a result of the production of one dwelling unit.

Part A of table 3 shows, for example, that the total requirement placed on the plastics materials and resins industry by the construction of a single-family house in 1963 was $96. Almost one-half of this amount was sold to the miscellaneous plastics products industry. Sales to the paint industry and asbestos products industry also account for substantial parts of the total.

The distribution of the sales of the railroad industry to its customers are shown in part B of the table. The distribution of railroad sales differs noticeably from that for the plastics materials industry in that the largest portion of sales are to the construction and mobile home industries rather than to intermediate industries. As can be seen, the construction of a single-family house generates total railroad sales of $479; over one-half of this amount consists of transportation services sold directly to the construction industry.

The table pinpoints several markets in which the impacts vary greatly by type of dwelling unit—information that would be particularly useful to a firm in planning its marketing strategy. For example, the sales of the plastics materials and resins industry to the coated fabrics industry are affected much more by the production of a mobile home than by any other type of unit; sales to the paint and allied products industry, however, are affected the most by the construction of a single-family house.

Table 3.—Sales of Two Selected Industries to Their Customers Per Dwelling Unit in 1963
[Dollars]

A. Sales of the plastics materials and resins industry to other industries

Type of unit	Total	New construction	Mobile homes	Coated fabrics not rubberized	Veneer and plywood	Paints and allied products	Miscellaneous plastic products	Asbestos products	All other industries
Single-family house	96	0	0	1	4	12	48	9	26
Two- to four-unit structure	64	0	0	1	2	8	29	7	17
Walk-up apartment	60	0	0	1	1	8	22	7	21
High-rise apartment	69	0	0	1	1	9	30	4	24
Mobile home	50	0	0	3	5	5	21	(*)	12

B. Sales of the railroads and related services industry to other industries

Type of unit	Total	New construction	Mobile homes	Sawmills and planing mills	Industrial inorganic, organic chemicals	Ready-mixed concrete	Blast furnaces and basic steel products	Primary aluminum	All other industries
Single-family house	479	209	0	13	3	18	20	2	164
Two- to four-unit structure	344	208	0	10	2	11	13	2	98
Walk-up apartment	274	139	0	4	2	10	18	2	99
High-rise apartment	284	118	0	2	3	10	26	4	114
Mobile home	128	0	56	3	1	(*)	10	4	54

*Less than $0.50.

Table 2.—Total Requirements Per Dwelling Unit in 1963—Continued
[Dollars]

High-rise apartment		Mobile home	
A. Materials		A. Materials	
1. Blast furnaces & basic steel products (176)	852	1. Veneer & plywood (268)	366
2. Ready-mixed concrete (550)	572	2. Motor vehicles & parts (302)	327
3. Metal doors, sash & trim (499)	537	3. Blast furnaces & basic steel products (197)	316
4. Sheet metal work (293)	319	4. Aluminum rolling & drawing (194)	267
5. Miscellaneous metal work (294)	282	5. Sawmills & planing mills (212)	219
6. Cement, hydraulic (74)	229	6. Millwork (266)	214
7. Aluminum rolling & drawing (1)	193	7. Primary aluminum (0)	161
8. Stone & clay mining & quarrying (28)	184	8. Heating equipment, except electrical (144)	152
9. Elevators & moving stairways (148)	180	9. Logging camps & contractors (0)	150
10. Petroleum refining & related products (22)	173	10. Metal doors, sash & trim (141)	146
B. Services		B. Services	
1. Wholesale trade (452)	704	1. Retail trade (667)	594
2. Miscellaneous professional services (471)	508	2. Wholesale trade (515)	473
3. Retail trade (446)	505	3. Real estate (25)	164
4. Real estate (74)	361	4. Railroads & related services (56)	128
5. Motor freight transportation (187)	326	5. Motor freight transportation (57)	114

Technical Note

Direct requirements per dollar of output of each type of residential construction were derived from the transactions table at the 478-industry level. In that table, each of the four types of construction covered in this article is shown as a separate industry (see footnote 1). As explained in the text, the direct requirements for a single-family house were increased to include the real estate commission.

Direct requirements per dollar of output of mobile homes were based on those for the trailer coach industry (I–O 61.06/SIC 3791) in the direct requirements table at the 367-

(Continued on page 38)

(*Continued from page 17*)
industry level. Mobile homes accounted for about 80 percent of the output of the trailer coach industry in 1963 with the remainder accounted for by smaller, recreational-type units. Because mobile homes accounted for most of the inputs to the industry and because the same types of inputs are used in the smaller units, it was assumed that the input pattern for mobile homes was the same as that for the total industry.

In order to achieve comparability with the data on inputs to construction, the furniture and appliances purchased by mobile home manufacturers for installation in the units were omitted, while the trade margin on the sale of the mobile home to its final purchaser and the transportation from factory to site were added.

The direct requirements per unit shown in table 1 were obtained by multiplying the direct requirements per dollar of output times the estimated unit costs on line D of table 1. The unit cost estimates for construction were derived from Bureau of the Census and FHA data. (It should be noted that there is some evidence that the 1963 unit cost of high-rise apartments may have been somewhat higher than that shown in table 1, which is based on the differential between walk-up and high-rise apartments insured by FHA.) The mobile home price was based on unit price data from the 1963 *Census of Manufactures* (adjusted to exclude furniture and appliances and to include transportation and trade margins).

The total requirements per dwelling unit shown in table 2 were obtained by taking the direct requirements per dwelling unit as a final demand and multiplying them by the coefficients in the total requirements table at the 367-industry level. (This rather involved computation is necessary because the total requirements table for the 367-industries—the most detailed available—does not contain separate columns for each type of construction which would permit the values to be obtained more directly.)

The distribution of an industry's sales as shown in table 3 is obtained in two stages. First, the total requirements placed on each industry as a result of producing a dwelling unit were computed as described above. Second, the direct requirements by each industry for plastics materials (or railroad transportation) were obtained by multiplying the total requirements times the direct requirements per dollar of its output by the industry for plastics materials (or railroad transportation).

Revised Estimates of Retail and Business Inventories

REVISED monthly estimates of retail inventories and of combined manufacturing and trade inventories starting in 1961 are shown in the accompanying tables. Also shown are revised inventory-sales ratios.

These tables reflect revisions in retail inventories and manufacturers' sales, both unadjusted and adjusted for seasonal variations, and in manufacturers' inventories adjusted for seasonal variations. The data for retail sales and for merchant wholesalers' sales and inventories have not been revised.

The report M3–1.2 *Manufacturers' Shipments, Inventories, and Orders: 1961–70*, available from the U.S. Government Printing Office, Washington, D.C. 20402 ($1.00 per copy), contains complete information on the revision of these series.

Retail inventories are estimated on an establishment basis each month by the Office of Business Economics, on the basis of sample data reported to the Census Bureau. The current revisions reflect adjustment of 1968 and 1969 figures to yearend benchmark data provided by the Census Bureau's *Annual Retail Trade Reports* for those years, as well as some adjustments for 1961–67 in the allocation of inventories among lines of trade within the nondurable goods group. Also, the seasonal factors for all lines of trade have been recalculated.

The revised estimate of total retail inventories at the end of 1969 is 2½ percent lower than that previously published, lowering the stock-sales ratio for December 1969 from 1.56 to 1.52. The revised inventory data were incorporated in the national income and product accounts in the regular annual revisions, published in the July 1970 SURVEY.

The 1968 and 1969 *Annual Retail Trade Reports* gave the first direct measures of inventories based on the new procedures introduced by the Census Bureau in 1965, and thus made possible an evaluation of the assumptions underlying the previous OBE estimates of inventories on the new basis for the period 1961–67 (SURVEY, November 1968, page 21). Examination of the Annual Report data and related information from the Internal Revenue Service's *Statistics of Income* indicated that the estimates for durable goods lines of trade in the 1961–67 period needed virtually no adjustment, and they have not been revised. However, sizable adjustments have been made in the 1961–67 estimates for some lines of trade within the nondurable goods group.

The principal procedural change introduced by the Census Bureau in 1968 concerned the treatment of "nonstores" (mail-order houses, vending machine operators, door-to-door salesmen, etc.). Nonstore retailers are now treated as part of the general merchandise group, whereas formerly they were included in the various lines of trade according to the type of merchandise sold. Sales data on the new basis cover the period beginning January 1968, and the Census Bureau constructed sales estimates on that basis back through August 1967. In order to provide consistent historical data by line of trade, OBE used techniques similar to those used by Census for late 1967 to construct sales estimates back through 1961 (SURVEY, November 1968, page 21 and May 1969, page 51). OBE's previously published estimates of inventories by line of trade on the new basis, also back through 1961, rested on the assumption that the procedural change had an impact on inventories commensurate with the then-measurable impact on sales. It is this assumption which has been reviewed in the light of further information.

Because of the procedural change in 1968, the line of trade data in the 1967 and 1968 *Annual Retail Trade Reports* are not comparable. Therefore, heavy reliance was placed on comparable 1967 and 1968 company data from *Statistics of Income* in calculating the yearend 1967 inventory levels on an establishment basis. Yearend levels for earlier years are based on the relative movements shown in the *Annual Retail Trade Reports*, with monthly interpolations based on data from the Census Bureau's monthly retail trade sample. Additional information on retail inventories, the sample design, and the reliability of the data can be found in the Census Bureau's 1968 and 1969 *Annual Retail Trade Reports* (BR–13–68 and BR–69–13).